

Terminal Velocity

LearnWell Academy

GCSE Physics Reading Notes

These notes explain terminal velocity in a simple, step-by-step way. They are designed to help students understand the forces acting on a falling object, how terminal velocity is reached, and what happens when a parachute opens.

Learning goals

- Define terminal velocity clearly.
- Explain how weight and air resistance change during a fall.
- Describe the stages of motion before and after a parachute opens.
- Interpret a velocity–time graph for a falling skydiver.
- Apply the idea of resultant force to real situations.

1. What is terminal velocity?

Terminal velocity is the constant speed reached by a falling object when the upward force of air resistance becomes equal to the downward force of weight. At this point the forces are balanced, so the resultant force is zero and the object stops accelerating.

Key idea

- If the resultant force is not zero, the object accelerates.
- If the resultant force is zero, the object moves at a constant velocity.
- Terminal velocity is a constant downward velocity.

2. Falling in a vacuum and falling in air

A falling object behaves differently in a vacuum and in air.

- In a vacuum there is no air resistance, so the only force acting is weight. The object keeps accelerating as it falls.
- In air, air resistance acts upward and increases as the object moves faster.
- Eventually air resistance becomes equal to weight, so the object reaches terminal velocity.

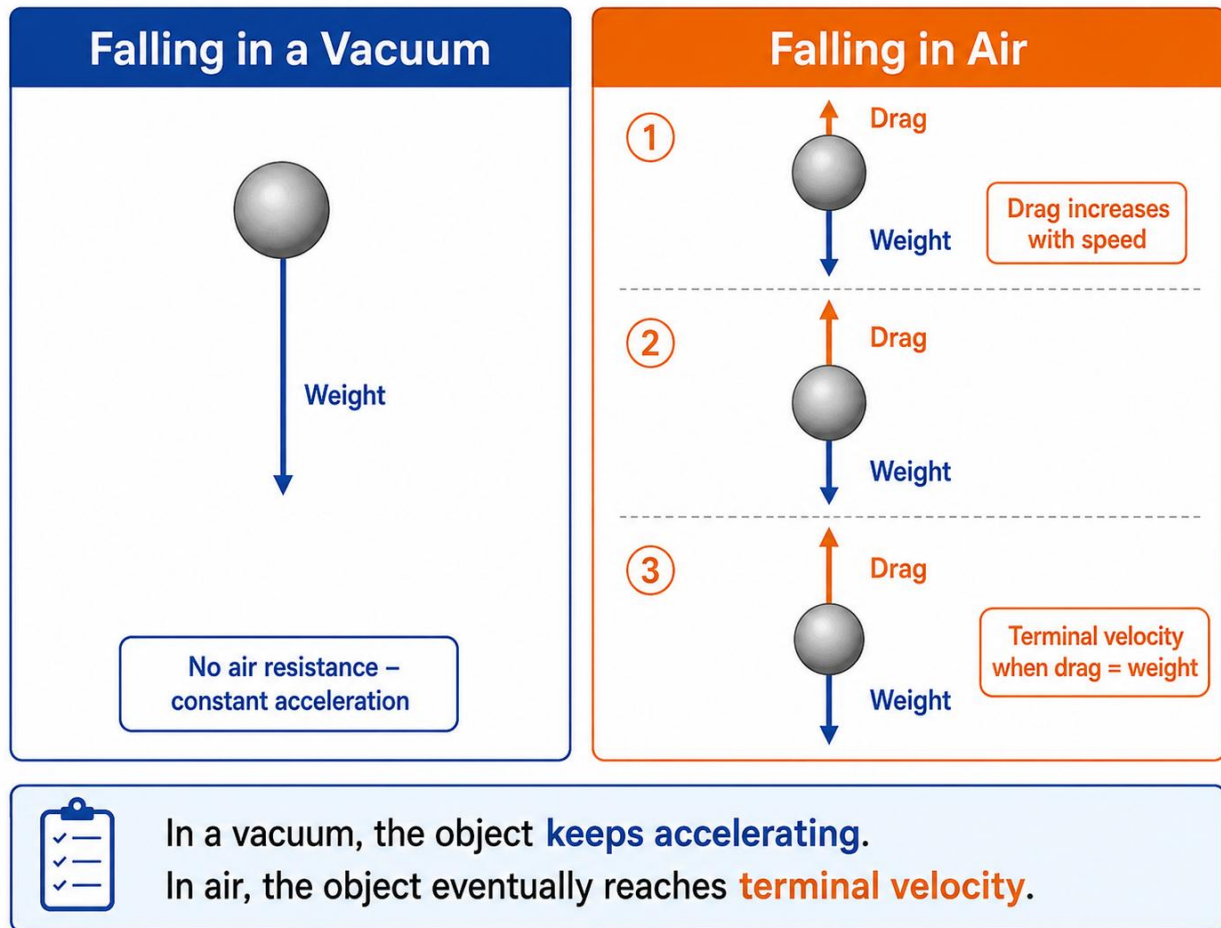


Figure 1: Comparison of falling in a vacuum and falling in air.

3. How terminal velocity is reached

The forces acting on a skydiver change as the skydiver speeds up.

- Just after the jump: weight is much larger than air resistance, so the resultant force is downward and the skydiver accelerates.
- Later in the fall: air resistance increases, so the resultant force becomes smaller and the acceleration decreases.
- At terminal velocity: air resistance equals weight, so the skydiver falls at a constant speed.

How Terminal Velocity is Reached

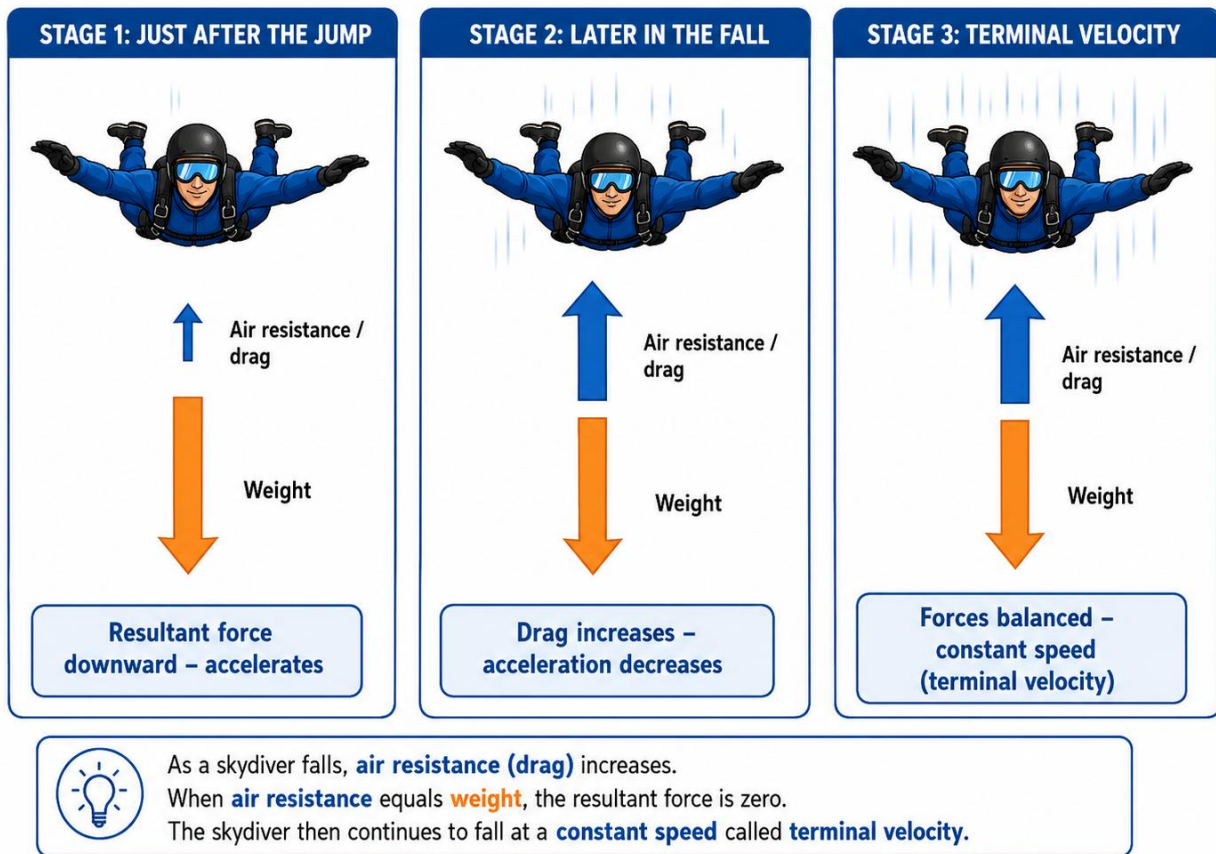


Figure 2: The three stages of reaching terminal velocity.

4. What happens when a parachute opens?

Opening a parachute greatly increases the surface area of the skydiver. This causes air resistance to increase dramatically.

- Immediately after the parachute opens, drag becomes much larger than weight.
- The skydiver decelerates rapidly because the resultant force is now upward.
- As the speed decreases, drag also decreases until it becomes equal to weight again.
- The skydiver then continues to descend at a new, lower terminal velocity.

Effect of Opening a Parachute

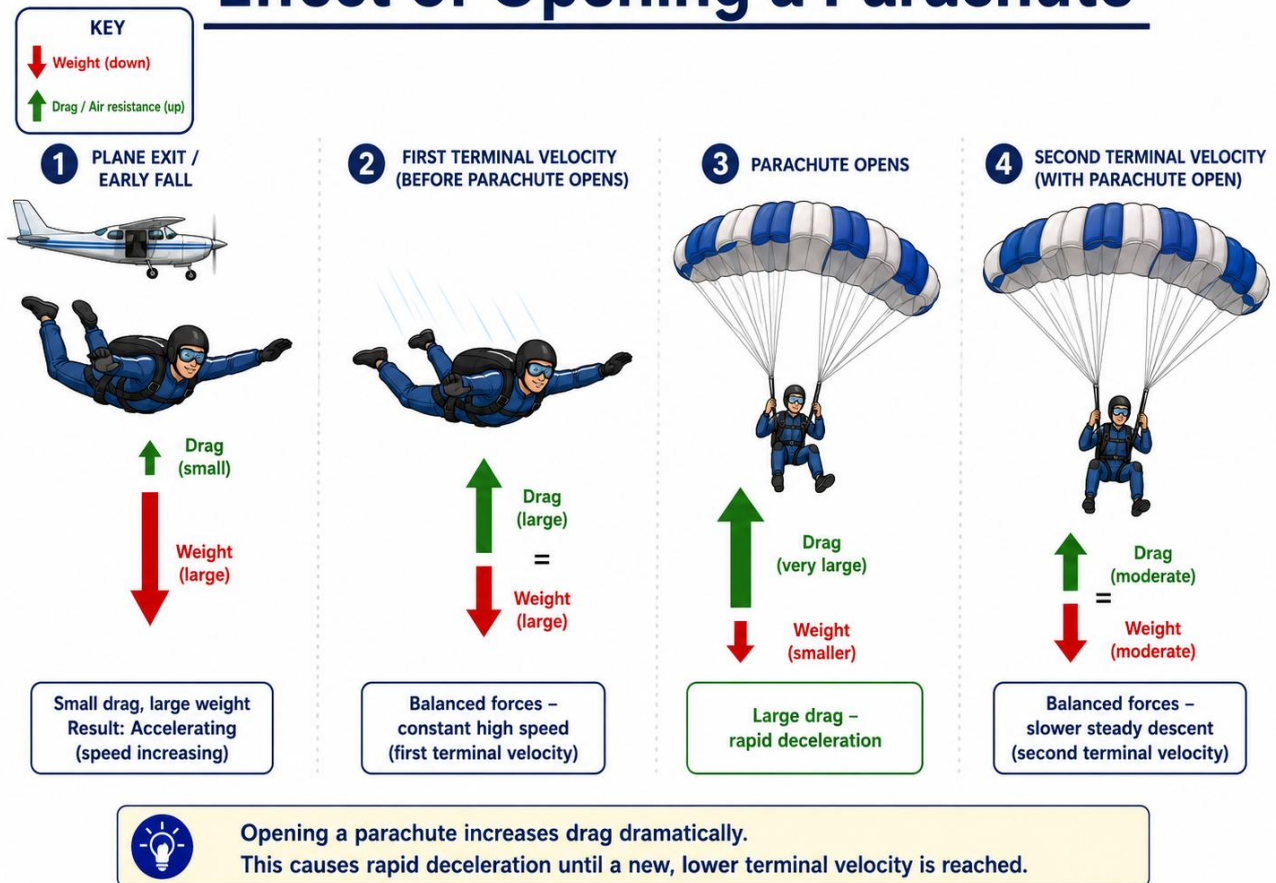


Figure 3: Effect of opening a parachute.

5. Velocity–time graph for a skydiver

A velocity–time graph helps us visualise how the speed of a skydiver changes during the fall.

Velocity–Time Graph for a Skydiver

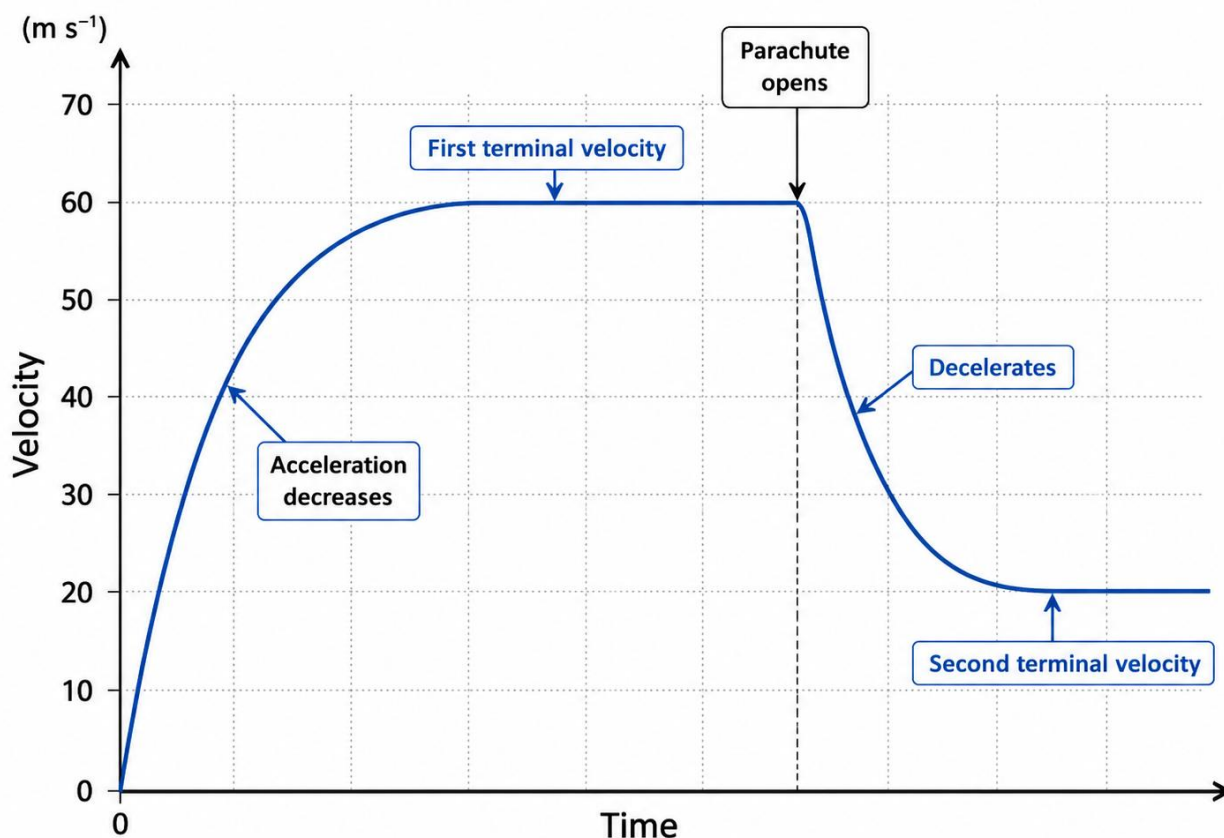


Figure 4: Velocity–time graph of a skydiver.

- At the start, the slope of the graph is steep: the skydiver accelerates quickly.
- The graph gradually levels off: acceleration decreases because drag is increasing.
- The first horizontal section shows the first terminal velocity.
- When the parachute opens, the velocity drops sharply: this is deceleration.
- The final horizontal section shows a second, lower terminal velocity.

6. Factors that affect terminal velocity

Different objects can have different terminal velocities. The main factors are:

Factor	How it affects terminal velocity
Mass / weight	A larger weight usually means a higher terminal velocity because more drag is needed to balance the weight.

Surface area	A larger surface area increases drag, so the terminal velocity is lower. This is why parachutes are effective.
Shape	Streamlined objects experience less drag and usually have a higher terminal velocity than flat or spread-out objects.
Density of fluid	Moving through denser fluids creates more drag. For example, motion through water is slowed much more than motion through air.

7. Worked example

A skydiver has a weight of 800 N and an air resistance of 200 N just after jumping from a plane.

Question

- Calculate the resultant force. State the direction of the force and explain what happens to the motion.

Step 1: Identify the forces.

Weight = 800 N downward

Air resistance = 200 N upward

Step 2: Calculate the resultant force.

Resultant force = $800\text{ N} - 200\text{ N} = 600\text{ N}$ downward

Step 3: Interpret the result.

Because the resultant force is downward, the skydiver accelerates downward. As the skydiver speeds up, air resistance increases until it balances the weight.

8. Common mistakes to avoid

- Do not say terminal velocity means the object has stopped moving. It is still moving, but at a constant speed.
- Do not confuse velocity with acceleration. At terminal velocity, velocity is constant and acceleration is zero.
- Do not say weight decreases as the skydiver falls. Weight stays approximately constant; it is drag that changes most noticeably.
- When a parachute opens, the skydiver does not immediately stop. The skydiver slows down until a new lower terminal velocity is reached.

9. Exam-style response

Question

- Explain why a falling skydiver eventually reaches terminal velocity.

Model answer:

When the skydiver first jumps, the only large force is weight, so the resultant force is downward and the skydiver accelerates. As the skydiver speeds up, air resistance increases. This reduces the resultant force and therefore reduces the acceleration. Eventually air resistance becomes equal to weight. The forces are then balanced, so the resultant force is zero. The skydiver continues to fall at a constant speed called terminal velocity.

10. Quick-check questions

- 1. What is meant by the term terminal velocity?
- 2. Which force increases as a skydiver speeds up in air?
- 3. What happens to acceleration when drag increases but is still smaller than weight?
- 4. Why does opening a parachute reduce the terminal velocity?
- 5. What is the resultant force at terminal velocity?

Answers

- 1. A constant speed reached when drag equals weight.
- 2. Air resistance (drag).
- 3. The acceleration decreases.
- 4. The parachute increases surface area, which increases drag.
- 5. Zero.

11. Knowledge organiser

Term	Meaning
Weight	The gravitational force acting downward on an object.
Air resistance / drag	A resistive force that acts opposite to the direction of motion through air.
Resultant force	The overall force after all forces are combined.
Terminal velocity	A constant speed reached when drag equals weight.
Parachute effect	Opening the parachute increases drag and creates a new, lower terminal velocity.

Prepared for LearnWell Academy tuition support. These notes are suitable for general GCSE Physics revision.